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PHYSICAL ACTIVITY

Effects of Personal Mobile Devices on Social Behavior and Physical Activity Among Young Adults: A Multi-Group Comparison Study

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Abstract

Young adults' personal mobile device use is at an all-time high. Social interaction and physical activity (PA) are generally positively associated in this population; however, the nature of this relationship is unclear when personal mobile devices (cell phones) are present. The objective of this study was to examine the social and PA behavior among college students with and without access to cell phones and a stimulus to be physically active. A between-group design that included fifty-six college students randomly exposed to one of four experimental conditions: 1) no phone/no equipment, 2) no phone/equipment, 3) phone/no equipment, or 4) phone/equipment, and were observed via hidden camera. A modified System for Observing Children's Activity and Relationships during Play (SOCARP) instrument was used to quantify PA, social group size, and interaction type. Significant differences were observed for PA level (p<0.001), social group size (p=0.03),

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physical prosocial (p=0.046), physical antisocial (p<0.001), and ignoring (p=0.037) interaction type across experimental groups with lack of access to cell phone and PA stimulus being most physically and socially active. The findings suggest that cell phones may have a detrimental impact, reducing PA engagement and impeding social interaction among young adults.

Introduction

Since gaining popularity in the late 1990s and early 2000s, Americans' use of personal mobile devices, such as cell phones, has consistently increased. It is estimated that the number of cell phone users in the United States will exceed 290 million by 2024 (O'Dea, 2020). Young adults (18-29 years old) have the largest percentage of cell phone ownership (96%) among all age groups (Pew Research Center, 2019). They are also the largest overall consumers of social media content (Pew Research Center, 2020). The use of cell phones to access social media, although designed to promote greater social interaction, has been linked to reduced interactions among young adults (Robert et al., 2014). In addition, increases in frequency and duration of cell phone use for social connection are associated with higher stress levels among young adults (O'Dea, 2020), as well as increased severity of depression and social anxiety (Pew Research Center, 2019) in this age group.

Social interaction is a crucial factor influencing the subjective well-being of all adults, particularly students (Dissing et al., 2019), and has consistently been shown to be positively correlated with personal physical activity (PA) in this population (Elhai et al., 2018; King et al., 2020). Engaging in both acute and habitual bouts of PA is associated with improved subjective well-being (Bauman et al., 2012); however, like many adults, college-aged adults do not participate in enough PA each day (Rhodes et al., 2017), with less than half meeting the daily recommendations (Weise et al., 2018). This lack of PA can be detrimental to young adults' mental health (Centers for Disease Control and Prevention, 2020) as well as potentially have long-term implications on activity patterns and overall health later in life (American College Health Association, 2019).

Though social interaction is recognized as a determinant of PA (VanKim & Nelson, 2013), there is no comprehensive understanding about factors that promote or inhibit regular PA levels among today's college-aged adults, who some consider the first digital natives (Dai et al., 2014). Recent studies indicate that among college students, higher frequency cell phone users were more likely to forego PA to use their cell phone (Lepp et al., 2013), and that high cell phone users are significantly more sedentary than low cell phone users (Barkley et al., 2016). In contrast, studies examining the use of social exercise cell phone applications (apps) have shown increases in PA because of their use (Romeo et al., 2019), however these investigations have only considered the effects of the apps on PA levels in aggregate, and the acute effects of access to mobile devices on PA remains understudied. Furthermore, to our knowledge, no studies have considered the acute direct effects of access to personal mobile devices on PA when opportunities to be both physically and socially active are available. Research shows that when children are presented with a stimulus for PA, such as playground equipment, along with discretionary time, such as recess or before/after school, their PA levels increase (Di & Papa, 2019). It is unknown if a similar response could be observed among college-age adults; however, college students regularly report participation in intramural activities as contributing to their social enjoyment and PA (Moore et al., 2010), thus it is plausible that these types of stimuli may encourage increased PA.

With modern societies becoming increasingly reliant on personal mobile technology, while also experiencing greater obesity rates and sedentary behavior, it is imperative to better understand how technology use directly impacts PA behavior. National surveys consistently indicate that college students face increasing mental health challenges, underscoring the importance of integrated wellness strategies on campus (American College Health Association, 2019; Institute of Medicine, 2013). Regular physical activity is associated with a wide range of health benefits in youth, including improved academic performance, physical health, and mental well-being (Carlson et al., 2008; Institute of Medicine, 2013). Therefore, the purpose of this study was to examine social interactions and PA among students with and without access to their personal mobile devices and a stimulus to be physically active. We hypothesized that social interaction and PA levels would differ among groups of college age adults who had either: (a) no access to their personal mobile device and no PA stimulus, (b) no access to their personal mobile device and a PA stimulus, (c) access to their personal mobile device and no PA stimulus, and (d) access to their personal mobile device and a PA stimulus.

Materials and Methods

Study Design

To test the hypothesis that social interactions and PA levels would differ among college age adults with and without their mobile device and a PA stimulus, **a between-group design** experiment was conducted with 56 college students, who were able to engage in physical activity, were observed via hidden camera with or without their cell phone and a PA stimulus including available space, time, and physical education (PE) equipment designed for physically active use. The sample size was determined to be sufficient via power analysis conducted using G*Power software. Data input for the power analysis was based on the effect sizes (partial $eta^2 = 0.20$) presented in Rebold et al. (2017). This study was conducted on 44 college-aged students and demonstrated large effect sizes for texting and talking on treadmill exercise. The power analysis suggested that a minimum of 48 participants were necessary for the current study to achieve adequate power. Participants were recruited from the university's SONA psychology research system, and each had a major area of study that was in or related to psychology (at the upper division third-year status). None had participated in research in the Kinesiology laboratory (where the research was conducted) prior to the current study. Prior to data collection, participants were pre-assigned to one of four experimental conditions: (a) No Cell Phone, No PE equipment, (b) No Cell Phone, PE equipment, (c) Cell Phone, No PE equipment, and (d) Cell Phone, PE equipment. The group conditions were designed to allow participants access to, or a lack thereof, their personal mobile device with or without a PA stimulus, to which the combination of available space, time, and PE equipment was considered a proxy.

In line with a pre-established research methodology, the authors deliberately refrained from collecting specific demographic data, including gender and participant age, for this study. This decision was grounded in a commitment to uphold ethical research standards, acknowledging the potential sensitivity and discomfort that inquiries into gender identity may elicit among participants. Furthermore, it was deemed that gender information bore no direct relevance to the study's particular research objectives, aligning with a methodology endorsed by research ethics boards (Cameron & Stinson, 2019). Despite the recognized existence of gender disparities within the physical activity literature, the authors opted to utilize a physical activity survey as the primary data collection instrument to ensure a homogenous representation of participants' physical activity characteristics.

Analysis of participant demographics revealed that age was not a pertinent variable for the statistical framework, as the age range of participants was relatively homogenous, spanning from 18 to 24 years. Additionally, all participants were enrolled in the same academic major, thus presenting a uniformity in academic and professional trajectories. This demographic homogeneity rendered age stratification in the dataset unnecessary. Gender-based considerations were also examined. Although specific gender data was not actively collected, the participant sample was representative of the university's overall gender distribution among full-time undergraduate students, which is composed of approximately 57% female and 43% male individuals. This comparability suggests that any findings pertaining to gender dynamics within the study are reflective of broader institutional trends. The authors wish to emphasize that all research procedures adhered to the principles outlined in the Declaration of Helsinki and underwent rigorous ethical evaluation, receiving approval from the University of Louisiana at Lafayette Institutional Review Board before the commencement of participant recruitment and data collection.

Test Procedures

To observe participants' unbiased behavior in each of the experimental groupings, it was necessary to use a certain amount of initial deception. As such, each predetermined experimental group of participants was invited to the research facility on separate days and briefed about the purpose of the study. During this briefing, participants were (deceptively) informed that they would be surveyed about their leisure time PA, personal affect, and salivary cortisol level. At this point, participants completed a baseline assessment of their personal affect. Then, participants were asked to enter a "waiting room" for a period of 12 minutes, and depending on their group assignment, were either required to surrender their cell phone or allowed to keep it on their person. The waiting room was either filled with PE equipment such as jump ropes, a variety of balls, paddles, and other implements, or it was completely void of any objects, depending on group assignment. Chairs were not provided in either condition nor were instructions given to any group about what to do while in the waiting room, except that they were expected to wait until researchers called them to a separate room where they would participate in the study. After the 12-minute (pseudo-waiting) observation period, students were asked to leave the waiting room one at a time, where they were informed that they had been deceived about the study procedures. Participants were informed that they had also been video recorded while in the waiting room and were given the option to drop out of the study and revoke their consent for their data, including video data, to be used in the study. Participants opting to remain in the study were post-tested for personal affect. None opted out of the study, and complete data were available for 56 participants.

Measures

The study employed the Positive and Negative Affect Schedule (PANAS; Cameron & Stinson, 2019) to assess the participants' personal affect before and after the study. A Leisure and Physical Activity (LPA) survey ensured the participants' relative homogeneity in terms of their regular PA levels. Furthermore, the System for Observing Children's Activity and Relationships during Play (SOCARP; 254) was utilized to assess both participant social interactions and PA levels during the 12-minute observation period.

PANAS

The PANAS is a 20-item scale designed to accurately capture the personal hedonic or affective level of individuals at a specified time, and is a valid and reliable instrument (265) that is widely used in studies in human psychology, including in studies conducted with young adults as participants (276). The PANAS consisted of 10 positive and 10 negative adjectives, on which respondents rated the extent to which each applied to them. The PANAS was set to a 5-point

Likert-style scale, and participants were instructed to indicate the extent to which they "felt this way at this very moment." Examples of emotions included on the PANAS were interested, distressed, irritable, alert, excited, ashamed, and upset. Participants were administered identical PANAS assessments at the initiation of the study and at its conclusion.

LPA Survey

With the comparative design of the study, we recognized that participant PA levels during discretionary time must be evaluated and controlled for; thus, prior to data collection, a Leisure and Physical Activity (LPA) Survey was developed based on the typical habits of college-aged adults. At the time of the study, no suitable PA surveys were available to evaluate college-aged adults' leisure-time PA specifically; therefore, it was decided to develop and validate an instrument to best fit the study population. The subsequently developed LPA Survey assesses respondents' participation in various leisure-time activities, including aerobic exercise and weightlifting, as well as sedentary activities such as working at a computer station, video gaming, and web surfing/entertainment. The LPA Survey questionnaire requires respondents to indicate a range of days per week (zero to two days, three to five days, or six to seven days) they participate in each of five leisure-time activities: (a) Typing/schoolwork on computer, (b) Web surfing/Entertainment (television, Facebook, Instagram, etc.), (c) Weightlifting (machine, free-weight, CrossFit, etc.), (d) Video gaming (Xbox, Nintendo, PlayStation, etc.), and (e) Aerobic exercise (running, walking, biking, aerobics, etc.). Respondents are also required to indicate the range of minutes spent in each activity (0-15 minutes, 16-30 minutes, and more than 30 minutes) when they participated in it.

The total scores for each LPA item were determined by summing the frequency and duration responses. The construct validity of the LPA Survey was established through correlational analysis of the individual items to respondent totals during a first pilot study conducted with 60 college-aged participants. The LPA Survey instrument had low item-to-total correlations ($r < 0.20$), indicating that the items measured different constructs.

Convergent validity of the exercise-related individual LPA Survey constructs (weightlifting and aerobic exercise) was established by correlating their resulting LPA values with other measures in which a theoretically strong relationship would likely exist. For example, in pilot testing, the weightlifting score demonstrated a strong, significant correlation ($r > 0.80$, $p < 0.05$, $N = 58$) to hand-grip strength, assessed by hand grip dynamometer (Jamar Hand Dynamometer, Sammons Prestons Bolingbrook, IL). Hand-grip strength is strongly correlated to participation in resistance training exercise (Leong et al., 2015; Leyk et al., 2007), supporting the convergent validity of the LPA weightlifting item.

Similar results were found in a separate pilot study for the LPA aerobic exercise total score and VO^2 max ($r > 0.60$, $p < 0.05$, $N = 12$), assessed via graded cardio-metabolic test (ParvoMedics TrueOne 2400, ParvoMedics, Sandy, UT). Strong associations between VO^2 max and habitual aerobic exercise have been long established (Berthouze et al., 1995), thus supporting the convergent validity of the aerobic exercise item in the LPA. Additionally, both the weightlifting and aerobic LPA total scores did not differ in a test-retest reliability study ($n = 389$, $p > 0.05$) that examined stability over a one-month time period (Bellar et al., 2014). Validity of the LPA items associated with sedentary behaviors (typing/schoolwork, web surfing/entertainment, and video gaming) was established by external examination of the survey by a panel of experts.

SOCARP

The SOCARP instrument was initially designed to evaluate both the social behavior and PA levels of elementary school-aged children while at recess or other discretionary play time on school playgrounds. The SOCARP instrument includes a 1-5 scale for assessing PA with the following scale descriptions: 1 = Lying, 2 = Sitting, 3 = Standing, 4 = Walking/Moderate, and 5 = Very Active/Vigorous. The SOCARP also allows for evaluation of group size as Alone, Small (2-4 individuals), Medium (5-9 individuals), and Large (10+ individuals), as well as activity types: Sport (engaged in sport-related activity), Game (active in game, not sport-related), Locomotion (movement that is not sport or game), or sedentary. The SOCARP social interaction definitions include None, Physical sportsmanship (physical pro-social), Verbal sportsmanship (non-physical pro-social), Physical conflict (physical antisocial), Verbal conflict (non-physical antisocial), and Ignoring (no response to a negative interaction).

For the purpose of this study, the SOCARP was modified in order to be appropriate for use with college-aged adults. Specifically, the social interaction descriptions were modified because the original SOCARP categories were designed to capture positive and negative interactions that are commonplace with young children at play. These types of interactions were unlikely to be present in the pseudo waiting room; thus, similar but more appropriate definitions were derived, such that Physical Sportsmanship was modified to Physical Prosocial (PP), and any behavior where the participant was observed being physically active with another was coded as such. Verbal Sportsmanship was modified to Verbal Prosocial (VP), which includes any verbal engagement with another participant without PA, and was coded. Physical Conflict was modified to Physical Antisocial (PA), and instances where participants were physically active by themselves were so coded. Verbal Conflict was modified to Verbal Antisocial (VA) to represent any verbal interactions that included arguing, making obscene gestures, or other anti-social behavior. In the modified version of SOCARP, the absence of any interaction is noted, whereas in the original SOCARP, ignoring was related to other participants' antisocial behavior.

The PA scale was also modified such that 1= Sitting, 2= Leaning (as in propped against wall, not standing on only feet), 3 = Standing, 4 = Walking/Moderate, and 5 = Very Active/Vigorous. The removal of the "Lying" criteria was critical to the sensitivity of the modified SOCARP to capture differences in PA, as it was determined that college-aged adults in a "waiting room" would be highly unlikely to lie down, thus leaving the category would only reduce the range of PA. The addition of the "Leaning" criteria was critical because no chairs were provided, and participants could choose to sit or stand, with many opting to lean against a wall.

The modified definitions of the SOCARP underwent assessment of difference by raters on a separate group of college-aged adults (*N* = 11) in a pilot study conducted by the three researchers involved in the current study. In this pilot study, participants were recruited from the Kinesiology department and instructed to spend 12 minutes in a pseudo waiting room filled with PE equipment. Participants were not asked to surrender their personal mobile devices. A video of the 12 minutes was coded independently by each researcher. Initial interrater agreement was poor, which warranted the researchers reviewing the video and recalibrating, particularly with regard to group size, as distances between individuals had to be standardized to determine if they were indeed grouped or not. After recalibration efforts, there was no significant main effect of rater ($\chi^2 < 1.4$, $p > 0.46$) or interaction effect of rater by time ($\chi^2 < 0.9$, $p > 0.77$) in any logistic regression model, which was considered sufficient for the reliability of data.

Statistical Analysis

Experimental group means and SD were calculated for PA from the modified SOCARP instrument, and all values are presented in Table 1. Numeric data was analyzed via a group-by-time analysis of variance (ANOVA). Categorical data from the SOCARP instrument was analyzed using categorical response analysis for multiple response data. Statistical significance was set at alpha < 0.05, and a modern statistical software package was used for all data analysis (JMP®, Version *13.0*. SAS Institute Inc., Cary, NC.). In instances where large numbers of results by time points are presented, *F* and *p* values will be listed as less than the greatest value below 0.05 or greater than the nearest value above 0.05.

Table 1
Mean and Standard Deviation of Physical Activity Levels by Cell Phone Use and PE Equipment Condition

Group	Mean	SD
No Cell Phone, No P.E. Equipment	1.10	0.49
No Cell Phone, P.E. Equipment	1.40	0.90
Cell Phone, No P.E. Equipment	1.07	0.45
Cell Phone, P.E. Equipment	1.08	0.49

Note: PA levels were measured using the modified SOCARP instrument. The PA mean values are based on a 1-5 scale where 1= Sitting, 2= Leaning (as in propped against wall not standing on only feet), 3 = Standing, 4 = Walking/Moderate, and 5 = Very Active/Vigorous

Results

The baseline data from the LPA survey indicated that the study population was moderately active, with 81% of participants reporting engagement in aerobic exercise on three or more days per week and 76% reporting that they performed at least 15 minutes of exercise per session. Additionally, 35% of the group reported engaging in three or more days of resistance training per week with 49% reporting 15 minutes or more per bout No differences by group were found for aerobic frequency or duration ($F < 1.3$, $p > 0.27$), nor weightlifting frequency or duration ($F < 0.82$, p > 0.51), suggesting all groups had similar composition regarding physical activity patterns.

Positive and Negative Affect

Analysis via repeated measures ANOVA (group x time) showed no significant difference by group ($F = 1.51$, $p = 0.224$) but did demonstrate a main effect for time ($F = 11.62$, $p = 0.001$) regarding positive affect. The analysis did not result in a significant interaction effect between group and time ($F = 1.59$, $p = 0.202$) for positive affect. With regard to negative affect, group x time ANOVA also showed no significant difference by group ($F = 1.15$, $p = 0.339$) and did not demonstrate a main effect for time ($F = 1.98$, $p = 0.165$). This analysis also did not result in a significant interaction effect between group and time ($F = 0.61$, $p = 0.612$) for negative affect. Ratios between positive and negative affect were analyzed using repeated measures ANOVA (group x time), and no significant difference by group ($F = 2.01$, $p = 0.124$) was observed, nor a main effect for time ($F = 1.87$, $p = 0.177$). Additionally, the group x time ANOVA for the positive-to-negative affect ratio did not result in a significant interaction effect between group and time ($F = 1.74$, $p = 0.171$).

SOCARP Variables

Participants' PA level during the 12-minute pseudo waiting room observation period ranged from 1.07 in the "Cell Phone, No PE Equipment" group to 1.40 in the "No Cell Phone, PE Equipment" group. Further analysis of participant PA level using repeated measures ANOVA (group x time) demonstrated a significant main effect for group ($F = 6.61$, $p < 0.001$), time ($F = 2.92$, $p = 0.009$), and interaction effect for group by time ($F = 4.37$, $p = 0.004$). Post hoc Tukey's HSD revealed that all group pairings differed from one another (*t*

> 7.49, $p < 0.001$), except for the comparison between the No Cell Phone and No PE Equipment groups.

Structured Chi-square multiple response analysis demonstrated that social group size 'S' ($\mathcal{X}^2 = 13.6$, $p < 0.001$) and 'M' ($\mathcal{X}^2 = 17.53$, $p < 0.001$) were significantly different by experimental group for the recorded session. Additionally, the Chi-square test of homogeneity of observation by group across all time points revealed significant differences ($\mathcal{X}^2 > 15.80$, $p < 0.030$) for social group size. Refer to Table 2 for the counts and percentages of time spent in each social group size.

Table 2
Social Group Size by Experimental Grouping

Experimental group	Group Size	Count	Percent
No Cell Phone, No PE Equipment	Alone	0	0%
	Small (2-4 individuals)	395	>99%
	Medium (5-9 individuals)	1	<1%
	Large (≥ 10 individuals)	0	0%
No Cell Phone, PE Equipment	Alone	109	25.20%
	Small (2-4 individuals)	316	73.10%
	Medium (5-9 individuals)	7	<1%
	Large (≥ 10 individuals)	0	0%
Cell Phone, No PE Equipment	Alone	180	21.70%
	Small (2-4 individuals)	432	52.20%
	Medium (5-9 individuals)	212	25.60%
	Large (≥ 10 individuals)	4	<1%
Cell Phone, PE Equipment	Alone	175	48.60%
	Small (2-4 individuals)	175	48.60%
	Medium (5-9 individuals)	10	<1%
	Large (≥ 10 individuals)	0	0%

Regarding the type of activity participants engaged in (Active Games, Locomotion, or Sedentary), a structured chi-squared multiple response analysis indicated that no experimental groups were significantly different from one another overall ($\mathcal{X}^2 < 6.54$, $p > 0.080$). Refer to Table 3 for the actual counts and percentages of time spent on each activity type.

Table 3

Activity Type by Experimental Grouping

Experimental group	Activity Type	Count	Percent
	Active Games	1	<1%
No Cell Phone, No P.E. Equipment	Locomotion	9	2.20%
	Sedentary	386	97.50%
	Active Games	12	2.70%
No Cell Phone, P.E. Equipment	Locomotion	64	14.81%
	Sedentary	356	82.40%
	Active Games	0	0.00%
Cell Phone, No P.E. Equipment	Locomotion	19	2.30%
	Sedentary	809	97.70%
	Active Games	23	6.39%
Cell Phone, P.E. Equipment	Locomotion	10	2.78%
	Sedentary	327	90.83%

For social interaction type (PP, VP, PA, and I), structured chi-squared response analysis demonstrated that PP ($\mathcal{X}^2 = 7.99$, p=0.046), PA ($\mathcal{X}^2 = 12.57$, $p = 0.006$), and I ($\mathcal{X}^2 = 8.48$, $p = 0.037$) were different by group across the session, with significant differences ($\mathcal{X}^2 > 12.5$,

$p < 0.05$) observed between groups across most (24 of 36) observations. No significant differences were revealed in VP ($\mathcal{X}^2 = 6.27$, $p = 0.099$) by group, and differences were observed in less than half of the coded time points. Table 4 includes counts and percentages of time spent in each social interaction type.

Table 4
Type of Social Interaction by Experimental Grouping

Experimental group	Interaction Type	Count	Percent
No Cell Phone, No P.E. Equipment	Physical, Prosocial	1	<1%
	Verbal, Prosocial	68	17.17%
	Physical, Antisocial	6	1.50%
	Ignoring	321	81.00%
No Cell Phone, P.E. Equipment	Physical, Prosocial	3	<1%
	Verbal, Prosocial	241	55.79%
	Physical, Antisocial	19	4.40%
	Ignoring	169	39.01%
Cell Phone, No P.E. Equipment	Physical, Prosocial	0	0.00%
	Verbal, Prosocial	258	31.16%
	Physical, Antisocial	15	1.81%
	Ignoring	555	67.03%
Cell Phone, P.E. Equipment	Physical, Prosocial	0	0.00%
	Verbal, Prosocial	0	0.00%
	Physical, Antisocial	33	9.17%
	Ignoring	327	90.83%

Discussion

The purpose of the current study was to examine social interactions and PA behavior when college-age adults did or did not have access to their personal mobile devices (cell phones) under conditions where a stimulus to be physically active was or was not present. Specifically, we hypothesized that social interactions and PA levels would be different based upon four experimental conditions where access to a cell phone and a PA stimulus were or were not present. The results of the study support this hypothesis and suggest that use of cell phones may reduce PA among college age adults, as the two experimental groupings with no access to their cell phones experienced significantly lower amounts of PA across the 12-minute pseudo waiting period (Barkley et al., 2016; Lepp et al., 2020; O'Dea, 2013). Additionally, in the conditions where PE equipment was introduced, PA levels increased, suggesting that when offered an alternative to engaging with a personal mobile device, college students tend to opt for more physically active pursuits (Di & Papa, 2019).

The results also suggest that the use of personal mobile devices may inhibit the quantity and quality of social interactions among college-age adults (Robert et al., 2014). This was evidenced by the experimental groups with access to their devices spending greater amounts of time alone, as opposed to being in small, medium, or large social groups, during the 12-minute pseudo waiting room observation period. Additionally, the participants in the two device-carrying experimental groups exhibited greater occurrences of ignoring and higher percentages of physical, antisocial behavior (i.e., being physically active alone) (Robert et al., 2014). While having possession of a personal mobile device would logically seem likely to result in more ignoring behavior, it is unclear exactly why the device-carrying individuals displayed more physical, antisocial behavior. It may have been a function of the passage of time during the 12-minute pseudo-waiting period, as most of these individuals paid attention to their devices (e.g., ignoring) at the initiation of the observation period. Then some opted for a physically active pursuit later in the observation period. We speculate that this initial ignoring behavior may have resulted in missed opportunities to engage with others that persisted even when choosing to be physically active.

In addition to promoting PA, the presence of a PA stimulus may have also facilitated an increase in social interaction, albeit with a less pronounced effect. In particular, the No Cell Phone, PE Equipment group exhibited the greatest prosocial behavior, and the absence of cell phones, combined with the availability of PE equipment, may have catalyzed some of this social interaction (Di & Papa, 2019). These interactions were primarily of the verbal, prosocial type; thus, in this case, not increasing both PA and social interaction simultaneously. In this No Cell Phone, PE Equipment group, however, there was an increased amount of time spent in physical, antisocial behavior, further supporting the notion that the presence of PE equipment increases the likelihood of PA, but not necessarily PA and social interaction simultaneously. Likewise, the Cell Phone, PE Equipment group had the highest proportion of time spent in physical, antisocial behavior, while also engaging in no physical or verbal, prosocial behavior (Di & Papa, 2019). While previous research among college students indicates a potentially reciprocal relationship between social interaction and PA (VanKim & Nelson, 2013), the results of the current study are not necessarily supportive, however the atypical clinical nature of the circumstances in which the two are compared in this study may have contributed to the lack of additive effect of PA and social interaction.

This study was different in its approach to examining college-age adults' social interactions and PA; however, some limitations should be considered. First, although the clinical nature of the study allowed for the reduction of extraneous variables and strengthened group comparisons, the results cannot be directly applied to all natural settings involving college-age adults. The results do allow for an initial comparison of how college-age adults may react when presented with social and PA alternatives to cell phone use in isolation. However, it cannot be assumed that the results discovered here will be typical in non-clinical settings. Future research should attempt to examine the impact of cell phone use on personal social interactions and PA outside of clinical settings. Additionally, although efforts were made to ensure homogeneity of participants on important variables (e.g., academic unit, experience in the Kinesiology lab, PA level), there may have been small, uncontrolled differences between experimental groups regarding their propensity to engage socially or be physically active during the observation period. Studies utilizing greater sample sizes in a variety of settings are needed to both replicate or refute our findings and provide a more complete examination of college-age adult behavior regarding cell phone use, social interaction, and PA.

It should also be noted that the data collection for this study took place prior to the COVID-19 pandemic, which may now limit the transferability of findings to a post-pandemic population, as it is generally accepted that the majority of young adults experienced greater social isolation and emotional distress during COVID-19 pandemic quarantine conditions (Tasso et al., 2021). Despite limitations, to our knowledge, this is the first study of its kind to explore the socio-behavioral tendencies of college-age adults with and without access to their cell phone and/or a stimulus to be physically active (Robert et al., 2014). The value of cell phones for a variety of modern purposes is unquestioned; however, the results of this study suggest that reliance on their use may promote unhealthy behaviors such as sedentary and antisocial behavior, especially among young adults. Habitual PA in adulthood is strongly predicted by behavior patterns established during early adulthood (American College Health Association, 2019); thus, understanding the factors that both promote and inhibit PA is paramount for future public health. In addition, with the prevalence of social/emotional distress on the rise among college age adults (Dissing et al., 2019), future research should examine the impact of cell phone usage on social interactions and consider how PA opportunities may offset antisocial behavior and promote more social interactions.

Conclusion

The findings of this study provide a foundational understanding of how cell phone use interplays with social behaviors and physical activity (PA) among college students. It is imperative that university administrators and policymakers heed the insights garnered from this research and proactively devise strategies that promote face-to-face interactions and PA within the student body. Institutions of higher education have a range of established social platforms at their disposal, including intramural sports, diverse student clubs, and numerous student-led organizations that foster a sense of community spirit. Building on these existing structures, universities could implement creative interventions. These might include designated 'phone-free' zones across campus to encourage live conversation, the implementation of peer-to-peer mentoring programs that embed counseling within active environments, the establishment of fitness groups such as walking or jogging collectives, and the intentional setting of social and emotional well-being objectives in all aspects of campus life. The integration of digital wellness workshops and gamification methods to incentivize participation in communal activities might be another avenue worth exploring. For such initiatives to be successful, they must be student-centered, grounded in research, and continually evaluated for effectiveness. By adopting a multifaceted approach that includes innovative program design and addresses the holistic needs of students, universities have the opportunity to significantly enhance both the social engagement and physical wellness of their student populations.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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